G2MARS a collaborative approach to improve fodder quality of European sorghum germplasm

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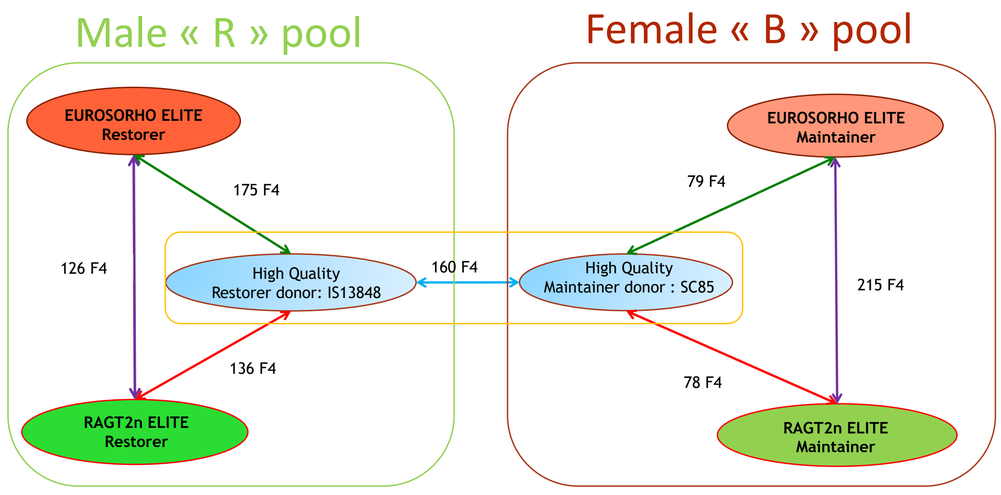
Breeding for Fodder quality : a multiparental marker assisted recurrent selection strategy

The ability of sorghum to maintain a high level of biomass production in stressfull environments makes it an interesting crop for animal feed as fodder, and for biomaterials and bioenergy production. Sorghum hybrids with improved agronomical behavior and high biomass quality are being developped for the European market. However the development of such hybrids requires a lot of field testing and biomass analyses. The current marker assisted breeding strategies offer the possibilities to better understand the genetic architecture of biomass quality and accelerate the creation of improved varieties. The G2MARS design developped in the frame of the Biomass For the Future project is gathering the know-how of both private companies and publics institutes to deliver new genetic marker and improved germplasm for the European biomass market.

1. Combining elite commercial material with high quality sorghum landraces



- 2 pools A/B and R analyzed
- Elites from Eurosorgho and RAGT2N
- 7 biparental F4 populations

2. Characterizing the topcross F4 populations

▪ Phenotyping

Mondonville trials (France) september 2017

- 969 hybrids grown at 2 locations in 2016 or 2017 in south west of France in augmented design with 3 controls.
- Scoring of agronomical characters : height, heading date, lodging, biomass yield,…
- Analysis of biomass quality : soluble sugar, starch, cell wall content and composition

▪ Genotyping

Pool	Cross	# Informative Markers
B	RAGT2n B X EUSG B	186
B	RAGT2n B X SC85	261
B	SC85 X EUSG B	248
BxR	SC85 X IS13848	260
R	EUSG R X IS13848	273
R	EUSG R X RAGT2n R	231
R	RAGT2n R X IS13848	274

- Genotyping with 544 SNPs markers
- Validation of the congruence between the genetic map and the physical map

3. Disentangling the genetic architecture of the target traits

- Clusters of QTL controlling several traits of interest were identified

- Detection of QTL both for agronomical and quality traits
- QTL detection performed with MCQTL taking advantage of the connected design
- 17 QTL detected in the R Pool and 6 in the B Pool
- Parental allelic effect ranked

4. Phenotypic and Molecular Ideotypes definitions : towards an optimal recombination strategy

Objective: Compiling within the 2 pools (B and R) all favorable alleles from the 3 differents parents into the same line.

Two ideotype targets

Ideotype 1:
++ Biomass yield
+ High soluble sugar level
++ High fiber digestibility.

Ideotype 2:
+ Biomass yield
+ Starch content (Grain)
++ High fiber digestibility.

Translating the phenotypic ideotypes into molecular ideotypes

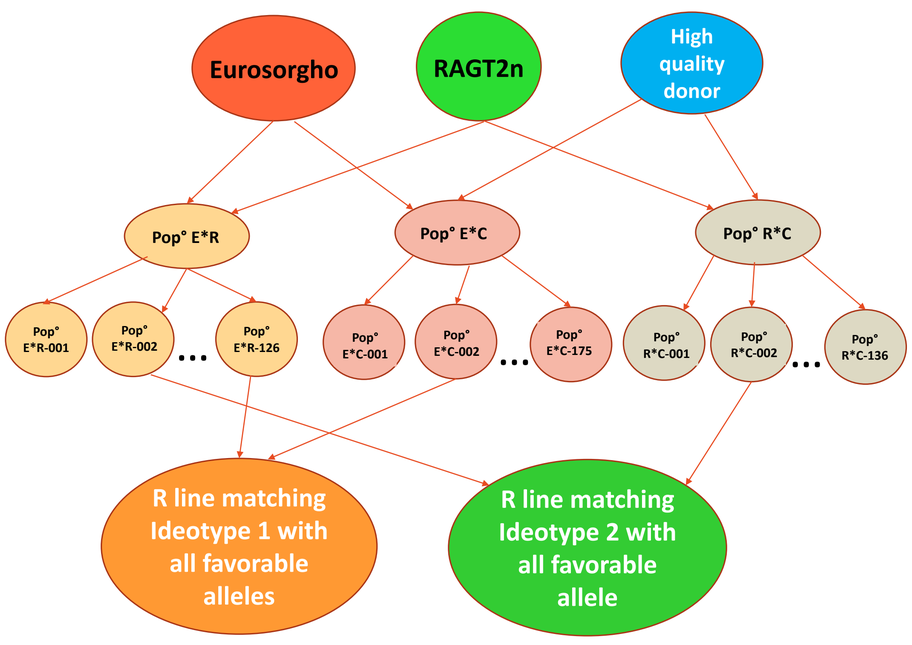
Choosing the best alleles based on QTL detection *

QTL #	Ideotype 1	Ideotype 2
1	EUG	EUG
2	EUG	EUG
3	EUG	CIRAD
4	EUG	EUG
5	EUG	EUG
6	CIRAD	RAGT
7	RAGT	RAGT
8	RAGT	RAGT
9	EUG	EUG
10	CIRAD	CIRAD
11	CIRAD	RAGT
12	RAGT	CIRAD
13	RAGT	CIRAD
14	RAGT	CIRAD
15	RAGT/ CIRAD	RAGT/ CIRAD
16	RAGT	RAGT
17	CIRAD/ EUG	CIRAD/ EUG

**for the R pool. EUG stands for Eursorgho Elite line, RAGT for the RAGT2n elite line and CIRAD for the high quality donor line*

Crossing scheme definition: the R pool example

ptiMAS



G2MARS outputs

- A private public partnership for the development of sorghum hybrids suitable for the biomass value chains
- A better image of the genetic architecture of biomass quality and yield in an elite germplasm context
- A recombination strategy anchored on a deep understanding of the genetic architecture of the target traits

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BFF Biomass For the Future